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THE INFLUENCE OF ARTIFICIAL RAINFALL AND Di-l-p-METHENENE ON KARBUTILATE MOVEMENT IN GREENHOUSE SOIL

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Edgewood Arsenal
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Oats	Bean plants	Growth
Avena sativa L.	*Phaseolus vulgaris* L.	Runoff
Greenhouse soil	Black Valentine beans	Karbutilate
Vapor Gard	Di-1-*p*-menthene	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Simulated rainfall was applied to flats of oats (*Avena sativa* L.) growing in greenhouse soil which had previously been treated with combinations of *m*-(3,3-dimethylureido)phenyl-*tert*-butyl-carbamate (karbutilate) and di-1-*p*-menthene (Vapor Gard).[2] Aliquots of the runoff from each treatment were applied to the roots of bean plants (*Phaseolus vulgaris* L. cv. Black Valentine) grown in solution culture as a bioassay for the presence of the herbicide. The growth of the bean plants treated with runoff water from the karbutilate + Vapor Gard treatment was significantly less

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20. ABSTRACT (Contd)

than the growth of the plants receiving runoff aliquots from the karbutilate treatment. The dry weight of oats clipped from flats treated with karbutilate was significantly less than the values obtained for the karbutilate + Vapor Gard treatment. These data suggest that Vapor Gard increased rather than decreased the amount of karbutilate in the surface runoff.

PREFACE

The work described in this report was conducted under Task 1W662605AD2801, Vegetation Control Technology. This work was started in December 1972 and completed in September 1973. The experimental data are recorded in notebook 8796.

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THE INFLUENCE OF ARTIFICIAL RAINFALL AND DI-1-P-MENTHENE ON KARBUTILATE MOVEMENT IN GREENHOUSE SOIL

R. M. See and W. Hurtt[1/]

ABSTRACT

Simulated rainfall was applied to flats of oats (Avena sativa L.) growing in greenhouse soil which had previously been treated with combinations of m-(3,3-dimethylureido)phenyl-tert-butyl-carbamate (karbutilate) and di-1-p-menthene (Vapor Gard).[2/] Aliquots of the runoff from each treatment were applied to the roots of bean plants (Phaseolus vulgaris L. cv. Black Valentine) grown in solution culture as a bioassay for the presence of the herbicide. The growth of the bean plants treated with runoff water from the karbutilate + Vapor Gard treatment was significantly less than the growth of the plants receiving runoff aliquots from the karbutilate treatment. The dry weight of oats clipped from flats treated with karbutilate was significantly less than the values obtained for the karbutilate + Vapor Gard treatment. These data suggest that Vapor Gard increased rather than decreased the amount of karbutilate in the surface runoff.

INTRODUCTION

The current emphasis on environmental quality and the danger posed by persistent pesticides has resulted in the removal of high-residue biocides from the agricultural market. The importance of pesticides to agriculture, combined with this growing environmental awareness, has accentuated the need for a method of increasing the efficacy of less toxic compounds by controlling residues, reducing movement from the target area, and temporarily protecting these compounds from degrading environmental factors.

Pinolene[3/] is a nontoxic polymer derived from pine resins consisting entirely of carbon and hydrogen. Several investigators have reported that the specific antitranspirant formulation of Pinolene (Vapor Gard) has successfully reduced damage due to water loss for several greenhouse and field crops (1,8).

Karbutilate is used as a soil-sterilant in noncrop areas. Optimum results are achieved with this compound when adequate rainfall is available to move the herbicide into the root zone. Although no specific information concerning the movement of karbutilate by surface runoff and subsequent distribution in aquatic ecosystems was found, the principles governing this diffusion and the impact of pesticides on aquatic populations have been reviewed by several investigators (2,3,9,10). The purpose of this investigation was to determine the effect of Vapor Gard on the movement of karbutilate in surface runoff under simulated rainfall conditions.

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2/ Product of Miller Chemical and Fertilizer Corporation, Hanover, Pa. 17331
3/ Product of Miller Chemical and Fertilizer Corporation, Hanover, Pa. 17331

MATERIALS AND METHODS

Flats 1.92 sq. m were lined with polyethylene plastic, filled with a standard greenhouse soil (Table 1) and seeded with oats. Two small holes were located at one end of each flat to allow for drainage. The flats were then placed in the greenhouse at 22 ± 5 C. Treatments were applied 5 days later when the oats were approximately 2 cm tall in a ventilated spray booth with an atomizer-type sprayer at 0.4 kg/sq cm. The total volume of application was equivalent to 1895 L/ha. Deionized water was used as the diluent in all treatments. Five replications were made of treatments consisting of 6.72 kg ai/ha karbutilate, and 6.72 kg ai/ha karbutilate + 17.92 kg ai/ha Vapor Gard, and a treatment of Vapor Gard alone. All flats were returned to the greenhouse for a period of 24 hours. During this period the temperature within the greenhouse was maintained at 22 ± 5 C, and the light-intensity ranged from 1.6 klux to 2.7 klux.

Table 1. Characteristics of the greenhouse soil used in this study

Property	
Soil texture	Sandy loam
pH (1:1 suspension)	6.2
Organic matter %	2.1
Bulk density (g/cm^3)[a]	1.22

[a] Oven dry basis

The previously treated flats were placed on a 33% slope and subjected to 5.1 cm of artificial rainfall in 11 minutes. The device used for simulating rainfall consisted of three overhead #8010 Tee Jet nozzles located 154 cm above the surface of the test flat and operated at a line pressure of 0.7 kg/sq cm. The runoff from each flat was collected in a stainless steel trough located at the base of the flat (Fig. 1). The effluent was transferred to flasks, capped with a nonabsorbent material and stored at 4 C until analysis could be made. An unwashed flat of each treatment was maintained as a visual comparison of herbicide activity as affected by the artificial rainfall. When runoff collections were completed, the flats were returned to the greenhouse for a period of 14 days. Dry weight values were obtained after the oats from each flat had been clipped at the soil surface and placed in a force-draft oven at 95 C for 24 hours.

Due to the solubility of karbutilate, 325 ppm at 21 C (4), the water samples were transferred from the cold storage to the laboratory and allowed to equilibrate at room temperature. Each sample was then shaken for approximately 1 minute and filtered through Whatman #1 filter paper in a Buchner funnel. Proportionate volumes of the runoff water collected from each flat of the same treatment were pooled prior to dilution in the bioassay.

Black Valentine bean plants were used as bioassay indicator plants for the presence of karbutilate in the runoff. Seed were germinated in premoistened vermiculite. Five days after planting, the bean seedlings were

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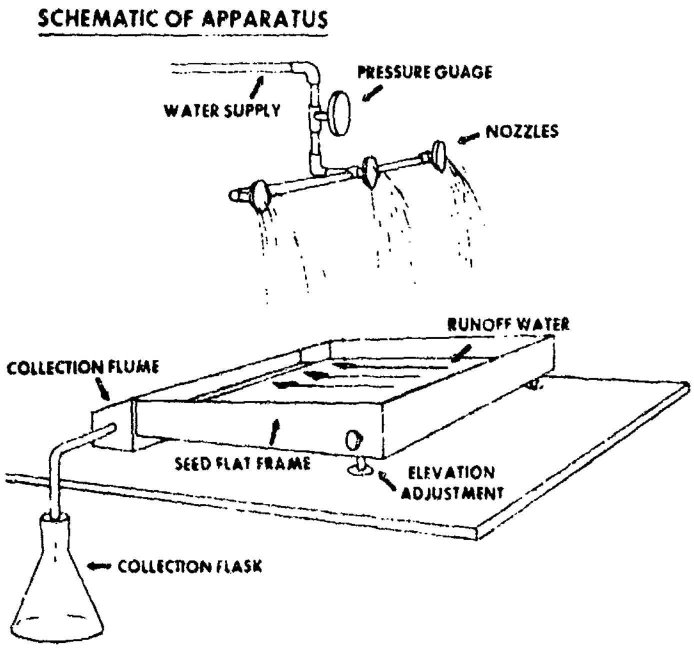

Figure 1. Schematic of apparatus used to simulate rainfall in the greenhouse.

transplanted into 0.5-strength aerated Hoagland's nutrient solution (7). The environment in the growth chamber throughout the growth period and subsequent bioassay was maintained at 25 ± 1 C and 50 ± 10% relative humidity. A 16-hr photoperiod of 1.3 ± 0.1 klux was supplied by a mixture of incandescent and fluorescent lamps.

Plants of uniform height were selected for experimental use 6 days after transplanting. Runoff aliquots were applied to the roots by adding the liquid directly to the nutrient solution. A completely randomized design with 10 replications was used. Initial plant heights were recorded on the day of treatment. Final heights and fresh weights of tops were recorded 10 days after treatment. Dry weights were obtained as before.

RESULTS AND DISCUSSION

Analysis of the growth parameters (change in height and dry weight of tops) from the bean bioassay indicates that the addition of Vapor Gard to the treatment solution significantly increased rather than decreased the quantity of karbutilate in the surface runoff (Fig. 2, 3). This increase in karbutilate did not result in growth inhibition until the second dilution level (2.5×10^{-2}) which exceeded the threshold level of the bean bioassay to karbutilate. The water samples collected from both treatments (karbutilate, karbutilate + Vapor Gard) significantly inhibited plant growth at the

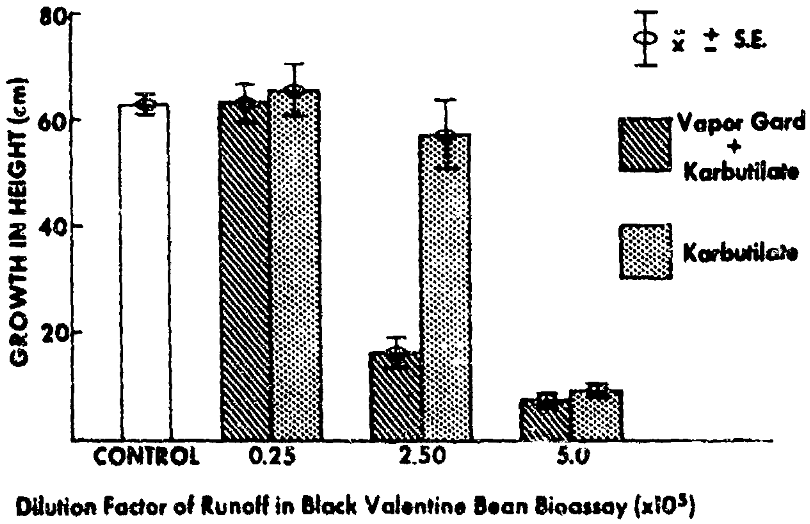

Figure 2. Effect of runoff water from flats of oat plants treated with 6.72 kg/ha karbutilate, 6.72 kg/ha karbutilate + 17.92 kg/ha Vapor Gard on the growth of Black Valentine bean assay plants.

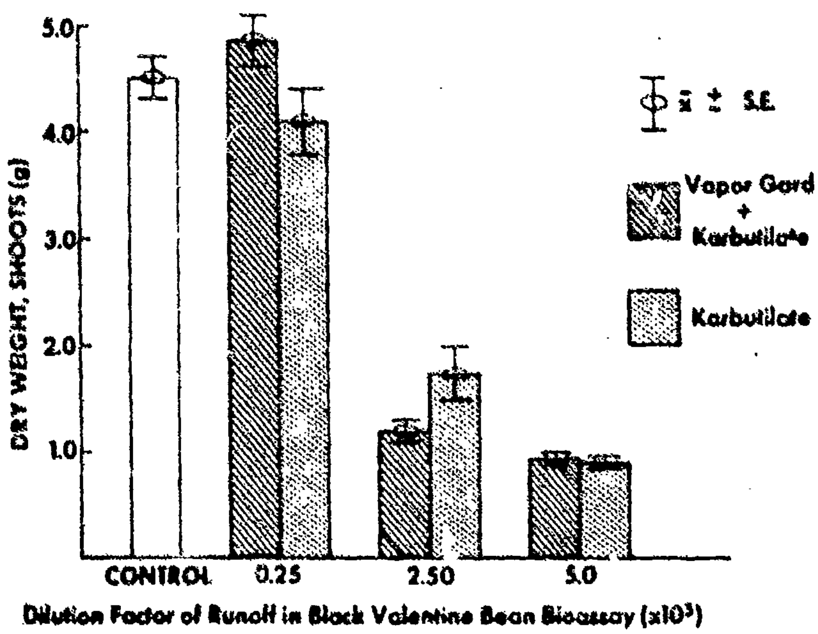

Figure 3. Effect of runoff water from flats of oat plants treated with 6.72 kg/ha karbutilate, 6.72 kg/ha karbutilate + 17.92 kg/ha Vapor Gard on the dry weight of Black Valentine bean assay plants.

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third dilution level (0.5×10^{-5}). Vapor Gard alone did not inhibit the growth of the oats in the test flats or the bean plants used in the bioassay.

The dry weight of oats clipped from treated flats also indicate that more herbicide was eroded from flats receiving the karbutilate + Vapor Gard treatment, as these values were not different from control values, but were significantly greater ($P \leq .05$) than the corresponding values from the karbutilate treatment (Table 2).

Table 2. Dry[a] weight of oats clipped from flats 14 days after treatment with 6.72 kg/ha karbutilate, 6.72 kg/ha karbutilate + 17.92 kg/ha Vapor Gard.

Treatment	Oven-Dry Weight, g[b]
Control	32.56 (28.83 - 36.29)
Karbutilate	20.96 (20.08 - 21.83)
Karbutilate + Vapor Gard	27.53 (25.82 - 29.24)

[a] 24 hrs following treatment all flats were placed on a 33% slope and subjected to 5.1 cm of artificial rainfall in 11 min.
[b] Values within parenthesis give upper and lower confidence limits at $P \leq .05$.

Several investigators have studied the movement of pesticides by surface runoff and soil erosion (6,7,12,13). Although these investigations involved different pesticides, application methods, soil types, topography, and environmental factors, it was conclusively shown that the amount of pesticide found in the sediment was up to 20 times greater than that quantity detected in the water portion of the runoff (6). Results from our investigation suggest that Vapor Gard may increase sorption of the herbicide on the soil surface particles. When rainfall occurs this increased adherence may temporarily reduce the vertical movement of the herbicide and therefore increase the karbutilate concentration of eroded soil particles.

The artificial rainfall system used in this investigation was designed to promote runoff and to an extent, soil erosion. The extreme slope (33%), volume and rate of rainfall (5.1 cm/11 min) was expected to cause excessive soil erosion. However, the 4 L of runoff contained only ca 2 g of eroded soil.[4/]

Although it would be difficult to attempt to accurately extrapolate the results of this investigation to field conditions, our results suggest that Vapor Gard temporarily retained karbutilate on the soil surface, thus making it more susceptible to movement from the target area when erosion occurred. Since eroded soils previously treated with pesticides are already a major source of surface water contamination (10), we feel considerable caution should be used when applying a pesticide in combination with any adjuvant of the spreader-sticker type which may retain the pesticide on the soil particles.

[4/] Oven dry basis

.038<

These results emphasize the value of controlling sediment losses from agricultural areas as an important method of reducing any potentially disruptive effect that pesticides may have on the components of aquatic ecosvstems.

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